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山茶属的花粉形态及其分类学意义*

韦仲新[1] M.S.Zavada[2] 闵天禄[1]

([1] 中国科学院昆明植物研究所，昆明 650204)

([2] 美国西南路易斯安那大学生物系)

摘要 本文对山茶属（*Camellia* L.）18 个组 27 个代表种的花粉进行了光学显微镜、扫描电镜和大部分进行了透射电镜的观察，并对花粉大小、形状、外壁纹饰和超微结构等作了综合的比较。结果表明，其形状和大小差异不很明显。花粉壁的层次、厚度和不同层次的比例，如复盖层与柱状层以及外壁外层与外壁内层的比例等也没有显著的差异。但花粉壁的纹饰特征在扫描电镜下显示出较大的差异，具有较重要的分类学价值。根据其纹饰特征，可以把山茶属花粉大致区分为六个类型：皱疣状纹饰；粗瘤状纹饰；颗粒状至皱–颗粒状纹饰；穴–网状纹饰；皱沟状纹饰及皱波–念珠状纹饰。孢粉学上区分的类型不完全与各个学者从植物形态上划分的组相一致。其中管蕊茶 *Camellia lanceolata* 的纹饰非常特殊（粗瘤状），其外壁表面很象牛心果（*Annona reticulata*）的外形特征，为其重新分类提供孢粉学依据。

关键词 花粉形态；山茶属；分类学意义

POLLEN MORPHOLOGY OF CAMELLIA(THEACEAE) AND ITS TAXONOMIC SIGNIFICANCE

WEI Zhong–Xin[1], M.S.Zavada[2], MING Tien–Lu[1]

([1] *Kunming Institute of Botany, Academia Sinica*, Kunming 650204)

([2] *Department of Biology, The University of Southwestern Louisiana*, Lafayette, Louisiana, U.S.A.)

Abstract Pollen grains of 27 species representing 18 sections of *Camellia* have been examined by light microscope (LM), scanning electron microscope (SEM) and mostly by transmission electron microscope (TEM). From the comparison of pollen size and shape, the exine sculpture, the pollen wall ultrastructure and exine stratification, we divided the pollen grains of *Camellia* into 6 types: 1. rugulate–verrucate; 2. coarsely warty; 3. granulate to rugulate–granulate; 4.foveolate–reticulate; 5. rugulate–fossulate; and 6. rugulate with beaded muri. These types are not in keeping with the sections divided morphologically by Mechior (1925), by Sealy J.R. (1950) or by Chang Hungta (1981—1982).

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Key words Pollen morphology; *Camellia*; Taxonomic significance

Since the founding of *Camellia* in the middle of 18th century, the number of species increased very rapidly from only 3 species to 100 or so species in the late 1950s, and recently up to more than 200 species. The same is true of the number of section. Melchior divided *Camellia* into five sections in 1925 [1], but in the late 1950s, Sealy, J.R.divided it into 12 sections [2]. By 1980s, with the discovering of new species rapidly, the number of section was increased up to 20 [3,4].

So far the pollen morphology of *Camellia* has received only a limited studies [5—9] in spite of its great importance in economy. Of those, furthermore, most confine to light microscope, only one work was done by scanning electron microscope [9]. In this paper, the authors examined 27 species representing 18 sections belonging to four subgenera: *Protocamellia, Camellia, Thea* and *Metacamellia* by LM, SEM and mostly by TEM, with emphasis on the sculpture, exine thickness and the ratios of tectum to columellae and ektexine to endexine aiming at providing some useful information for the classification, especially for the delimitation of section and the evolution relationship of *Camellia*.

Materials and Methods

All the pollen grains are taken from the Herbarium of Kunming Institute of Botany, Academia Sinica (KUN) with the exception of *Camellia lanceolata* which is taken from the Herbarium of Royal Botanic Gardens Kew, London, England (K). Table 1 listed the collections and locations of all species.

Pollen grains were treated by 5% KOH before treatment of acetolysis method of Erdtman. For LM, pollen is mounted in glycerin jelly and slide sealed with Canada blasam. Measurements are based on 10 to 20 pollen grains from each collection. For SEM, acetolyzed pollen is dehydrated in an EtOH series from 30% to 100% and after 2—3 changes of 100% EtOH, pipetted the EtOH containing pollen on to the specimen stubs covered with Apiezed Wax W100, coated with gold by Balzer CDS 040 gold sputtr and observed and photographed with S–450 SEM. For TEM, acetolyzed pollen is processed as follows: put the acetolyzed pollen into 1% agar solution, after centrifugation, cut the bottom part of agar and dehydrate at different concentrations from 30% to 100% of EtOH and last at 100% acetone. After 2—3 changes of acetone, the infiltration can be started by adding Spurr's low viscosity embedding medium to an equal quantity (1:1) of acetone left in the vial containing pollen grains. Swirl the mixture and let sit from 30 to 60 min, add the same amount of embedding mediun to the existing infiltration medium, swirl and let sit for another 30 min. Pour and drain the mixture and add more embedding medium. A second change can be made before the final embedding. Polymerization takes 8 h at 70℃ in an oven. The block containing pollen grains is trimmed and the pollen is then sectioned with grass knife on ultramicrotome. The sections are stained with 1% $KMnO_4$ and examined and photographed with TEM of model H–600.

Result and Discussion

The palynological characters such as aperture type, pollen shape and size, exine sculpture, pollen wall ultrastructure and stratification are summarized in Table 1. The exine morphology (endomorphology) will be discussed under the following headings:

Nonapertural exine sculpture. This refers to all external surface features of nonapertural exine and usually is taken to include only feature of the outer exine surface.

Nonapertural exine structure. It refers to all internal morphological features of nonapertural exine. In pollen grains of *Camellia*, the nonapertural exine is not uniform morphologically, i.e., interstitate, and usually has columellate interstitia that consist of a series of upright, rod–like structural elements known as columellae. The thickness of the nexine, interstitium and tectum as a percentage of total nonapertural exine thickness is ofter a taxonomically important character [10]. In this paper we give more consideration to thickness of exine and the rations of tectum to columellae and ektexine to endexine.

Exine stratification. Exine stratification refers to chemical differences that may be evident in various layers or strata of the exine. It is clear that the exine of pollen grains of *Camellia* consists of two different layers chemically, i.e., an outer layer—ektexine (with denser electron) and an inner layer—endexine (with less dense electron). Here the ektexine corresponds to sexine and nexine 1, and endexine is equivalent to nexine 2.

Aperture and nonapertural ultrastructure. In all pollen grains of *Camellia* examined, the endexine is frequently thicker under the apertures, and in some species the tectum on apertural zone is very thin or absent and in a few case the endexine represent the whole exine to some extent.

The exomorphology and endomorphology of pollen grains of *Camellia* may be summarized as follows:

1. Pollen shape and size

In general, pollen grains suboblate, subspheroidal to subprolate; usually 3–colporate, ora various, transversely parallel; pollen size varies from species to species, usually 35—45(—55) × 37—48(—57) μm. But three groups can be divided basically according to the size; one group with size from 30—40 μm diameter; the second group 40—60 μm diameter; the third group with size small than 30 μm diameter (Table 1); exine usually 1.5 to 2(—2.5) μm thick, rugulate or with obscure pattern under LM; sexine thicker than nexine.

Table 1. Pollen morphological data of *Camellia*

taxon	collection	location	aperture type, pollen shape and pollen size(μm)	exine sculpture	exine ultrastructure		
					exine thicken–ess (μm)	T: Co	Ekt: End
Sect. Archecamellia *C.pleurocarpa*	Kim.1961,1,23	Vietnam	3–colporate,subspheroidal to oblate (35.5—42.2)37.5 × 43(36—44.5)	rugulate–fossulate			
C.amplexicaulis	Zhong Yue group 2456	Vietnam	3–colporate, subspheroidal (34—41.8)36.8 × 38.8(36—42.2)	rugulate–fossulate			
Sect. Stereocarpus *C.sarcantha*	V.N.W.61–1–13	Vietnam	3–colporate,subspheroidal to oblate (35.5—42.3)40.1 × 48(37.5—50.5)	rugulate–fossulate			

Table 1 (cont.)

taxon	collection	location	aperture type, pollen shape and pollen size(μm)	exine sculpture	exine ultrastructure		
					exine thickeness (μm)	T: Co	Ekt: End
Sect. Camellia *C.luopingensis*	Sun Hong 479	Yunnan, China	3—colporate, suboblate (43.8—50)45.7 × 55.3(53.1—59.4)	rugulate—verrucate	1.5—2	2.5—3	4—5
C.mairei	Wang Qiwu 86350	Yunnan, China	3—colporate,suboblate (45—52.1)50 × 61(55.2 × 63.4)	rugulate with beaded muri	1.5—2	2.5—3	4—5
C.xylocarpa	Yu De jun 16021	Yunnan, China	3—colporate,suboblate (40.6—46.9)44.1 × 50.4(46.9—57.8)	rugulate—fossulate	1.5—2	2—2.5	4—5
C.pitardii	Yang Jing—sheng 63—2452	Yunnan, China	3—colporate,suboblate (43.8—53.2)48.6 × 51.6(46.9—54.7)	rugulate—fossulate	2—2.5	2.5—3	4—5
C.japonica	Yu Xiaolin 900506	Guangxi, China	3—colporate,suboblate (45.5—53.2)47.5 × 54.7(46.9—59.4)	rugulate—fossulate	2—2.5	2.5—3	4—5
Sect.Paracamellia *C.kissi*	Chen Jie 748	Yunnan, China	3—colporate, subspheroidal (34.3—36)35.5 × 36.5(35—36.8)	rugulate with beaded muri	2—2.5	2.5	4.5—5
Sect. Oleifera *C.oleifera*	Sun Hong 0138	Yunnan, China	3—colporate, oblate (43.4—50)48 × 50.8(43.4—56.3)	rugulate with beaded muri	1.5—2.5	2—2.5	4—5
Sect. Furfuracea *C.furfuracea*	Xie Lishan 627	Guangxi, China	3—colporate,subspheroidal—oblate (37.5—43.8)39.1 × 41.6(37.5—45.3)	rugulate—verrucate	1.5—2	2.5—3	4—5
Sect. Tuberculata *C.tuberculata*	Wang Fazan 22660	Xichuan, China	3—colporate,suboblate (34.4—50)44.4 × 51.8(37.5—59.4)	rugulate—fossulate	1.5—2	2.5—3	4—4.5
Sect. Pseudocamellia *C.henryana*	Xu Chaogui 3538	Yunnan, China	3—colporate, subspheroidal—oblate (40.6—45.7)42.9 × 47.5(43.8—50)	rugulate with beaded muri	1.5—2	2.5—3	4—5
C.yunnanensis	Wang Wencai 307	Yunnan, China	3—colporate,subspheroidal—oblate (34.4—43.4)38.2 × 44.6(37.5—46.9)	rugulate with beaded muri	1.5—2	2—2.5	4—5
Sect. Luteoflora *C.luteoflora*	Zhang Zanying A	Guizhou, China	3—colporate,suboblate (43.8—53.2)48.5 × 50.8(47—54.5)	rugulate—fossulate			
Sect.Chrysantha *C.chrysantha*	Xie Lishan 901	Guangxi, China	3—colporate,subspheroidal—oblate (43.8—46.9)45.4 × 49.4(46.9—53.1)	rugulate—fossulate	1.5—2	2—2.5	4.5—5
Sect. Calpandria *C.lanceolata*	D.E.Elmer 14282	Pro.Bagulo Philippines	3—porate,subspheroidal (35—37.5)36.5 × 37.5(35—38.5)	coarsely warty			
Sect. Longissima *C.hekouensis*	Wang Chong—jiao at al 904	Yunnan, China	3—colporate,prolate—subspheroidal (34.4—40.6)37.1 × 33.3(28.1—37.5)	rugulate—granulate	1.5—2	2—2.5	4.5—5
Sect. Longipedicellata *C.indochinensis*	South Guizhou group 287	Guizhou, China	3—colporate,oblate (34.4—42.4)38 × 40.7(37.5—43.8)	rugulate—fossulate	1.5—2	2—2.5	4—5
Sect. Corallina *C.wardii*	Tao Guoda 13007	Yunnan, China	3—colporate,oblate (34.4—40.6)37.7 × 38.6(34.4—42.2)	foveolate—reticulate	1.5—2	2.5—3	4—5
Sect. Brachyandra *C.pachyandra*	Zhang Fangci 002	Yunnan, China	3—colporate,prolate—subspheroidal (21.9—26.6)25 × 22.8(21.5—25)	foveolate—reticulate	1.5—2	2.5—3	4—5
C.gilbertii	He Kou group 68	Yunnan, China	3—colporate,oblate (23.4—28.1)24.7 × 26(23.4—29.7)	granulate to rugulate—granulate			
Sect.Thea *C.sinensis*	Li Yanhui 5152	Yunnan, China	3—colporate,subspheroidal—oblate (40.6—53.1)47.7 × 53.5(46.9—62.5)	rugulate with beaded muri	2—2.5	2.5—3	4—5
C. kwangnanica	Wu Quanan 9818	Yunnan, China	3(—2)colporate,subspheroidal to oblate (43.8—46.9)44.7 × 48(46.9—50)	rugulate—verrucate	2—2.5	2.5—3	4—5
Sect.Theopsis *C.tsingpienensis*	Wu Quanan 62—196	Yunnan, China	3—colporate,spheroidal (46.9—50)49 × 50.7(48.4—53.1)	rugulate—fossulate	1.5—2	1.5—2	4—5
C.tsaii	Wu Sugong 3853	Yunnan, China	3—colporate,prolate (59.4—67.2)62.2 × 56.5(50.4—62.5)	rugulate—fossulate	1.5—2	2—2.5	4—5
Sect. Camelliopsis *C.wenshanensis*	Cai Xitao 58—8295	Yunnan, China	3—colporate,oblate (46.9—50)48.5 × 50.4(46.9—53.1)	rugulate—fossulate	1.5—2	2—2.5	4—5

* notes: T = tectum; Co = columellae; Ekt = ektexine; End = endexine.

2.Exine sculpture

Exine sculpture under SEM is variable throughout the genus. Based on the sculpture of nonapertural exine, 6 distinctive types are evident.

(1) rugulate–verrucate　This type is very particular by composing of various shapes and sizes of verrucate structures. There are only a few species in this type, such as *C. luopingensis*(Sect. Camellia, Ⅱ–B); *C.furfuracea* (Sect. Furfuracea, Ⅲ–E) and *C. kwangnanica* (Sect. Thea, VI–B).

(2) coarsely warty　In this type, the surface of the pollen grain is composed by many coarsely warty structures which are nearly the same size, the whole pollen (SEM photo)likes a fruit of *Annona reticulate*to some extent. This sculpture is seen only in *C. lanceolata* (Sect. Calpandria, Ⅳ–C,E).

(3) granulate to rugulate–granulate　Of all the species examined only two have granulate to rugulate–granulate sculpture, i.e., *C. gilbertii* (Sect. Brachyandra, V–F) and *C.hekouensis* (Sect. Longissima, Ⅳ–F,V–A). These two species belong to Subgenus Thea.

(4) foveolate–reticulate　There are only two species in this type. *C.wardii* (Sect. Corallina, V–C,D) and *C.pachyandra* (Sect. Brachyandra, V–E) are the examples. On the surface of exine, there are a lot of different shapes (mostly polygonal) and sizes of lumina. This type belongs to Subgen. Thea.

(5) rugulate–fossulate　The exine surface of this type is multirugulate, the muri are composed by various vermiculate structures. Between the muri a lot of channels and pits or foveolae can be seen. (Ⅱ–E, F; Ⅲ–B; Ⅵ–E).Belonging to this type are *C. pleurocarpa* (Ⅱ–A)(Sect. Archecamellia) *C. xylocarpa* (Ⅱ–E) *C pitardii* (Ⅱ–F), *C. japonica* (Ⅲ–B) (all belonging to Sect. Camellia); *C.tuberculata* (Sect. Tuberculata, Ⅲ–F); *C. luoteoflora* (Sect. Luteoflora, Ⅳ–B); *C. chrysantha* (Sect. Chrysantha, Ⅳ–D); and *C. indochinensis* (Sect. Longipedicellata, V–B) etc. Most species of this type belong to Subgenera Protocamellia, Camellia and Thea.

(6) rugulate with beaded muri　In this type ,the exine muri are composed by many different shapes and sizes of more or less beaded structures. *C. mairei* represents typically this type (Sect. Camellia, Ⅱ–D).other species having this character are *C. kissi* (Sect. Paracamellia, Ⅲ–A); *C. oleifera* (Sect. Oleifera, Ⅲ–D); *C. henryana* (Sect. Pseudocamellia, Ⅳ–A) and *C. sinensis* (Sect. Thea, Ⅵ–D). Most species of this type belong to Subgen. Camellia.

3. Pollen wall ultrastructure and stratification

Of all the species examined by TEM, the nonapertural exine can be divided into four layers: the tectum, columellae, foot layer and endexine. The first three layers comprise ektexine.

In general, the exine thickness of most species is 1.5 to 2.5 μm (nonapertural zone), the tectum is thick and the foot layer is thin; but on or near colpus, the tectum and foot layer are very thin. The thickness of endexine varies very much from nonapertural zone (very thin) to copus (very thick). In most case the thickness of ektexine is 4 to 5 times the thickness of endexine. In some species, the foot layer is irregular and has some lamellae, such as *C. japonica* (Ⅶ–1), *C. gilber tii* (Ⅶ–14) and *C. tsaii* (Ⅶ–17,18). In other species, some lamellae structure also can be seen on or near colpus, but the lamellae are highly irregular and discontinuous, such as *C. chrysantha* (Ⅷ–1) and *C. pachyandra* (Ⅷ–12). In quite a few species there are more or less dispersed granules on the inner surface of endexine, such as *C. xylocarpa* (Ⅶ

—5), *C. tuberculata* (Ⅶ—14), *C. wardii* (Ⅷ—9), *C. wenshanensis* (Ⅷ—15), *C. tsaii* (Ⅷ—17,18) and *C. oleifera* (Ⅷ—19). In a few species near or on the colpus, the endexine forms spongy structure or the spongy structure interlocked with lamellate endexine, such as *C. wardii* (Ⅷ—10,11), *C. pachyandra* (Ⅷ—12), *C. gilbertii* (Ⅷ—14) and *C. furfuracea* (Ⅶ—19). The ratio of tectum to columellae is (1.5) 2 to 2.5 (3); the ratio of ektexine to endexine is 4 to 5. As far as the exine thickness, the ratios of tectum to columellae and ektexine to endexine are concerned, there are no remarkable differences among various species or even different sections.

Finally, we may draw the following conclusions:

The pollen morphology shows that *Camellia* appear to be a relatively homogenous group basically, having the same aperture type with the exception of *C. lanceolata* which is 3–porate; with middle–sized pollen grains. In addition, they have nearly the same exine thickness (1.5—2μm) and the same ratios of tectum to columellae (2—3) and ektexine to endexine (4—5);

Of all pollen morphology data, the variation in exine sculpture is the most important pollen character differentiating different types. Based on the sculpture, six types are evident, i. e., rugulate–verrucate; coarsely warty; granulate to rugulate–granulate; foveolate–reticulate; rugulate–fossulate; and rugulate with beaded muri;

Camellia wardii (Sect. Corallina) and *C. pachyandra* (Sect. Brachyandra) have most similar and particular exine sculpture (foveolate–reticulate), which suggests that the two species be placed in the same section;

C. lanceolata (Sect. Calpandria) has a unique exine sculpture–coarsely warty, its appearance (in SEM photo) like a fruit of *Annona reticulata*. Palynology supports to treat it as a separate Subgenus or even higher taxon;

Nearly all the species examined, the thickness of endexine varies very much from nonapertural zone to colpus (apertural zone), when comparison we must compare the nonapertural zone's endexine between different species, only in doing so can we provide a useful information and palynological data;

The study shows that there is no evident correlation between the palynological types (here divided into 6 types) and the sections recognized by Melchior (1925), Sealy J.R. (1950) or by Chang Huangta (1981–1982).

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Explanation of plates

Plate Ⅰ

1. *C. yunnanensis;* 2.*C. luopingensis;* 3.*C. xylocarpa;* 4. *C.japonica;* 5,6. *C. pitardii;* 7. *C.furfuracea;* 8. *C. oleifera;* 9, 10. *C. henryana;* 11. *C. indochinensis;* 12. *C. furfuracea;* 13. *C. hekouensis;* 14,15. *C. chrysantha;* 16. *C. indochinensis;* 17. *C. lanceolata;* 18,19. *C. kwangnanica;* 20. *C. wardii;* 21. *C. pachyandra;* 22. *C. sinensis;* 23. *C. tsaii;* 24. *C. wenshanensis;* 25. *C. wardii;* 26,27. *C. tsingpienensis.* (all × 900)

Plate Ⅱ

A. *C. pleurocarpa;* B. *C. luopingensis;* C. *C. sarcantha;* D. *C. mairei;* E. *C. xylocarpa;* F. *C. pitardii.*

Plate Ⅲ

A. *C. kissi;* B. *C. japonica;* C. *C. yunnanensis;* D. *C. oleifera;* E. *C. furfuracea;* F. *C. turberculata.*

Plate Ⅳ

A. *C. henryana;* B. *C. luteoflora;* C. *C. lanceolata;* D. *C. chrysantha;* E. *C. lanceolata;* F. *C. hekouensis.*

Plate Ⅴ

A. *C. hekouensis;* B. *C. indochinensis;* C. *C. wardii;* D. *C. wardii;* E. *C. pachyandra;* F. *C. gilbertii.*

Plate Ⅵ

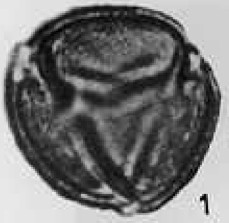
A. *C. amplexicaulis;* B. *C. kwangnanica;* C. *C. tsingpienensis;* D. *C. sinensis;* E. *C. wenshanensis;* F. *C. tsaii.*

Plate Ⅶ

1. *C. japonica,* X5000, note the foot layer lamellate (arrow); 2. *C. luopingensis,* X8000, the granules disperse on the inner surface of endexine (arrow); 3. *C. mairei,* X8000, note the thick endexine near colpus (upper part of section); 4. *C. pitardii,* X6000, the endexine near the colpus is very thick (lower part of section); 5. *C. xylocarpa,* X6000, note the granules on the inner surface of endexine; 6. *C. sinensis,* X5000; 7. *C. sinensis,* X8000; 8. *C. kwangnanica,* X8000; 9.*C. Kwangnanica,* X2000, the section cuts exactly the whole pollen grain, note the thick endexine near the colpus (arrows) and thin endexine (mesocolpia); 10. *C. Kwangnanica,* X4000; 11. *C. yunnanensis,* X3000, the section cuts across the whole pollen grain, note the endexine near and in the three colpi (arrows) much thicker than in other mesocolpia zone, and in the three colpi there are no tectum and columellae to be seen, the foot layer discontinuous; 12. *C. yunnanensis,* X5000; 13, *C. yunnanensis,* X12000, note discontinuous foot layer and blurred tectum; 14. *C. tuberculata,* X12000,note a lot of granules disperse on the inner surface of endexine; 15. *C. tuberculata,* X4000; 16. *C.tuberculata,* X8000; 17. C. henryana, X12000; 18. *C.furfuracea,* X6000, note the thick endexine in the middle part and thin endexine on the both sides; 19. *C. furfuracea,* X5000, note thin endexine in mesocolpia zone and spongy endexine near the colpus on the right; 20. *C. henryana,* X15000, note thick endexine on colpus.

Plate Ⅷ

1. *C. chysantha,* X12000 note the endexine lamellate and granules interlocked (arrow); 2. *C. chrysantha,* X5000; 3. *C. kissi,* X6000; 4. *C. kissi,* X10000; 5. *C. hekouensis,* X15000, note thin endexine (upper part) and extremely thick endexine (lower part); 6. *C. hekouensis,* X6000; 7. *C. indochinensis,* X6000; 8. *C.indochinensis,* X8000; 9. *C. wardii,* X10000, a few granules disperse on the inner surface of endexine; 10. *C. wardii,* X6000; 11. *C. wardii,* X6000, note the interlocked lamellate and spongy endexine in the colpus (arrow); 12. *C. pachyandra,* X15000, note the interlocked lamellate and spongy endexine (arrow); 13. *C. pachyandra,* X5000; 14. *C. gilbertii,* X8000, note lamellate foot layer (arrow); 15. *C. wenshanensis,* X8000, note some scattered granules on the inner surface of endexine (arrow); 16. *C. tsingpienensis,* X5000; 17. *C. tsaii,* X6000; 18. *C. tsaii,* X8000, note the foot layer lamellate (arrow); 19. *C. oleifera,* X8000, note a few scattered granules on the inner surface of endexine (arrow).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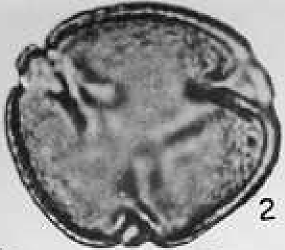
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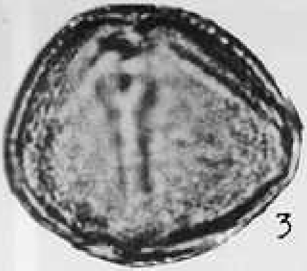
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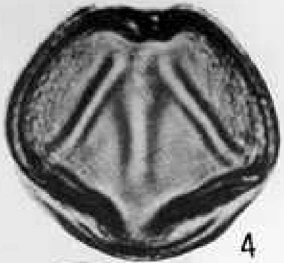
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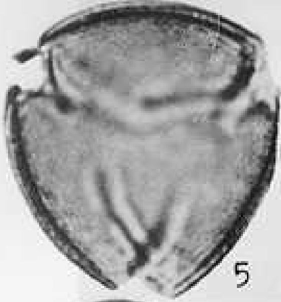
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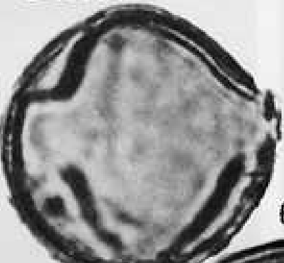
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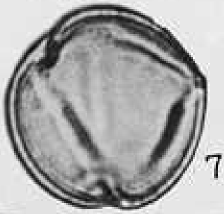
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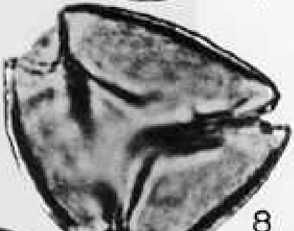
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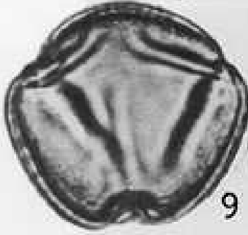
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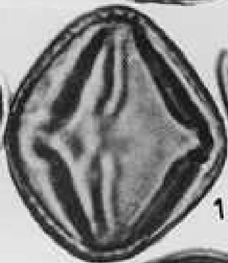
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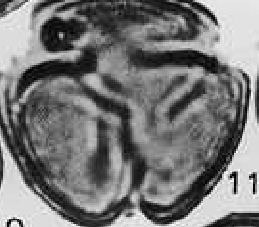
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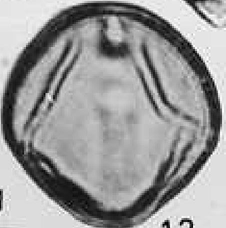
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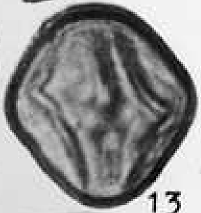
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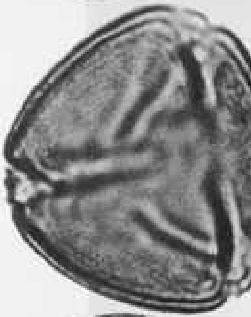
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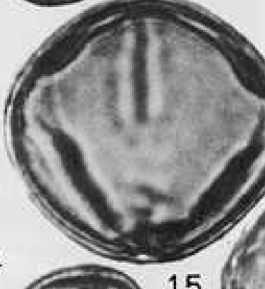
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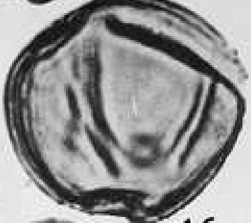
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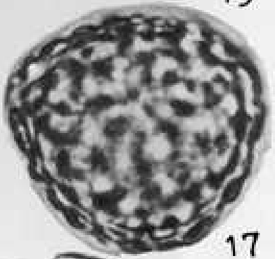
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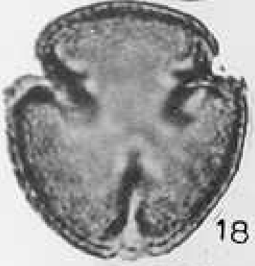
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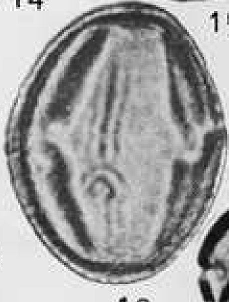
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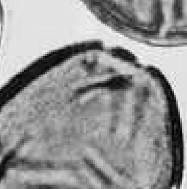
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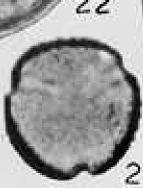
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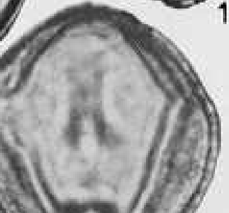
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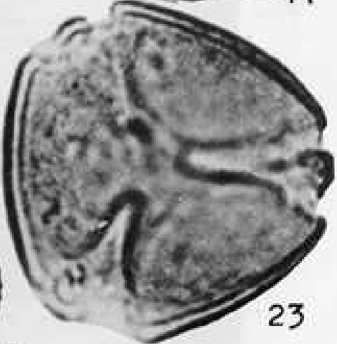
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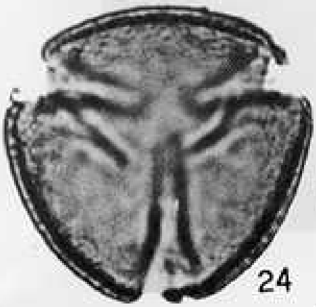
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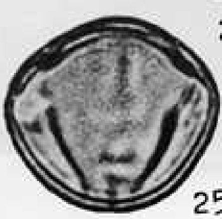
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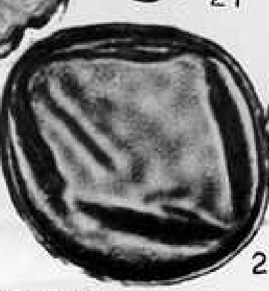
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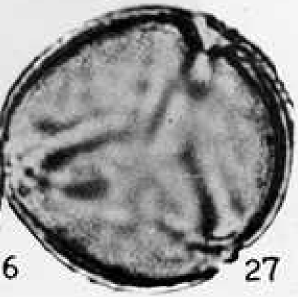
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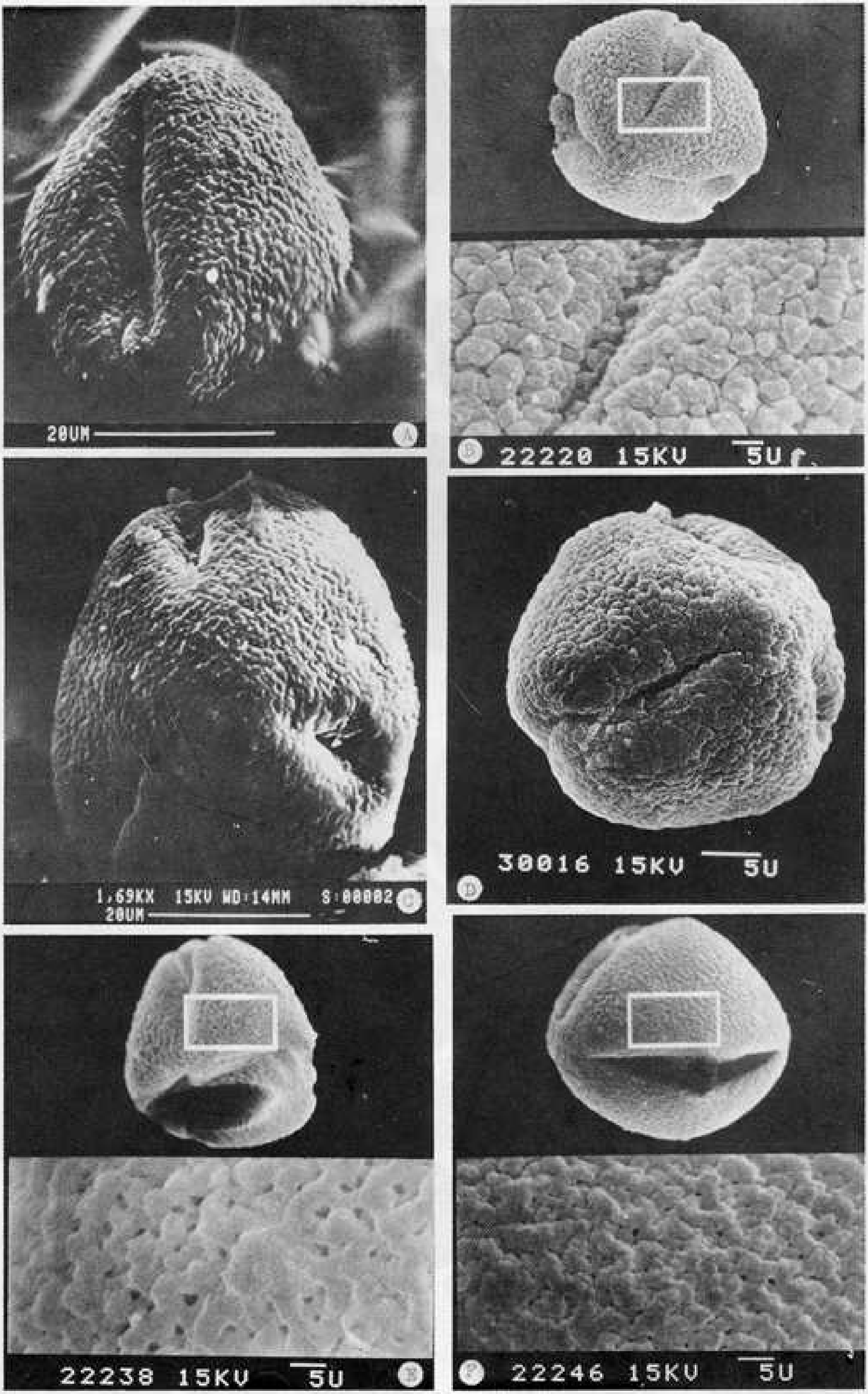

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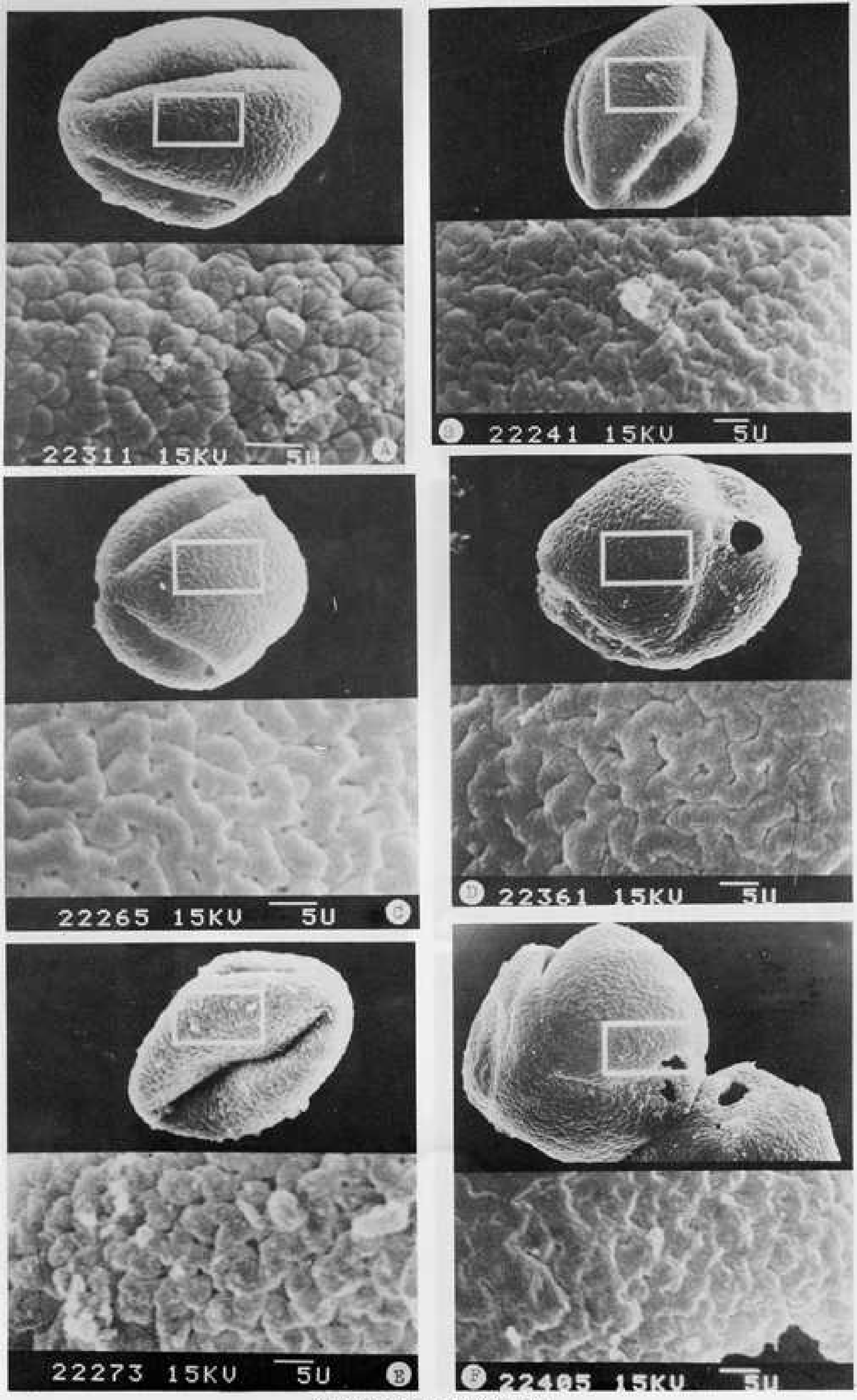

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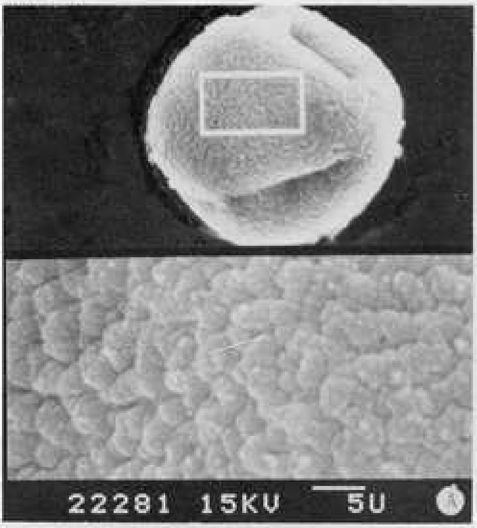

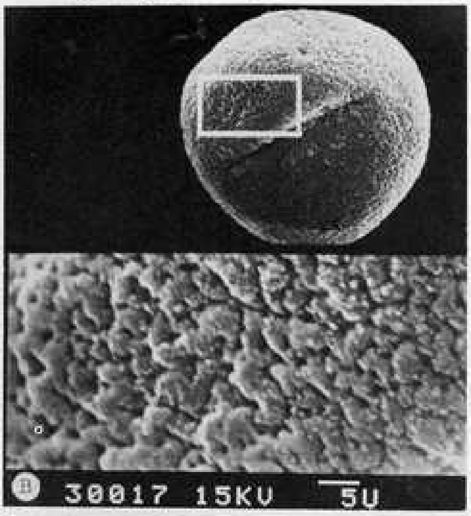

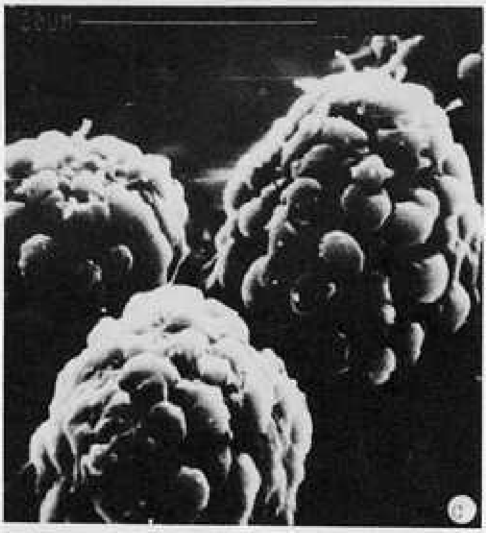

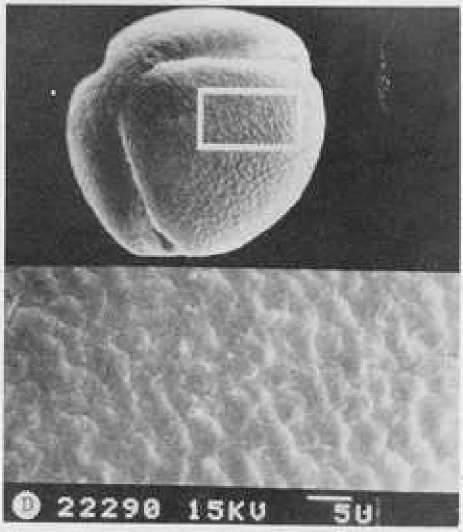

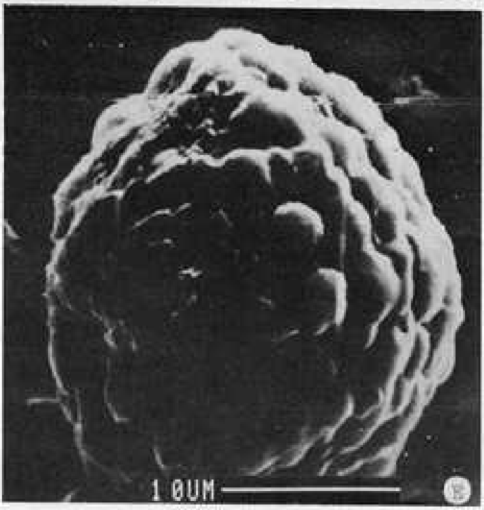

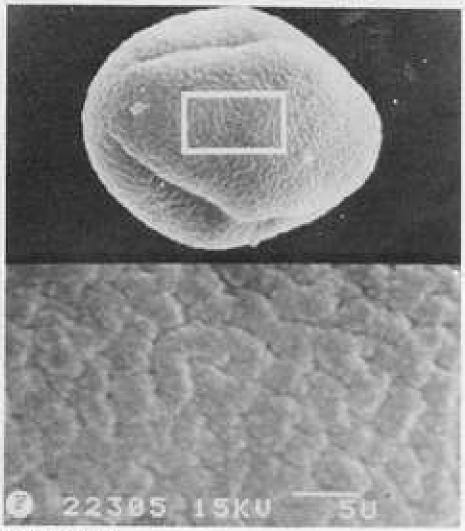

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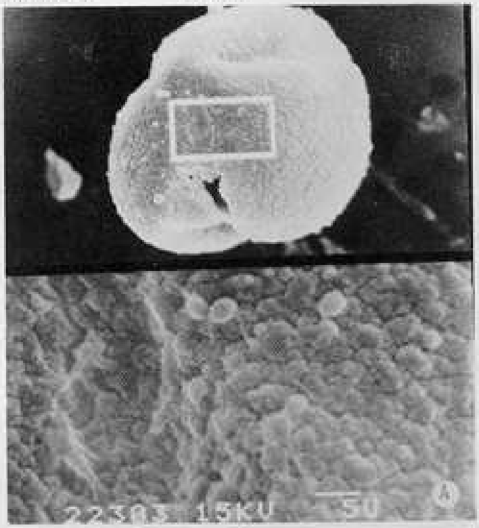

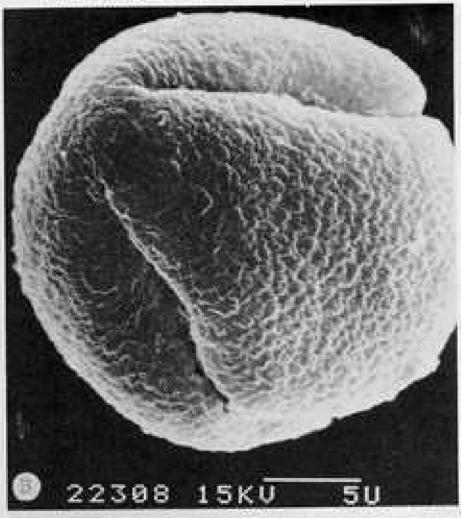

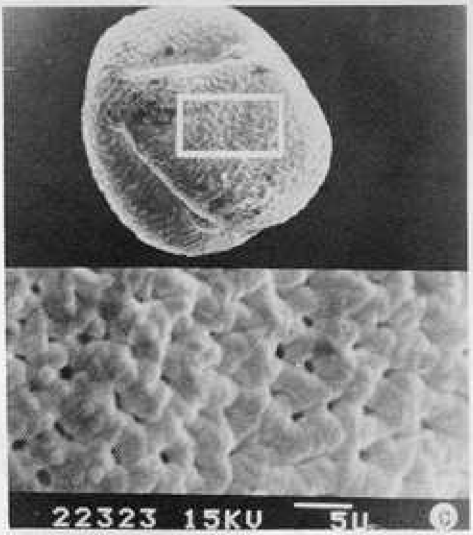

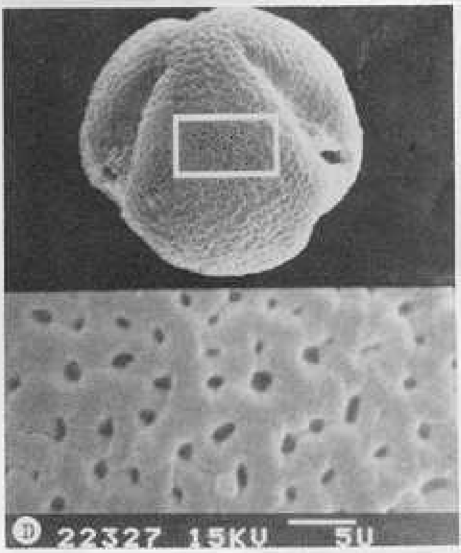

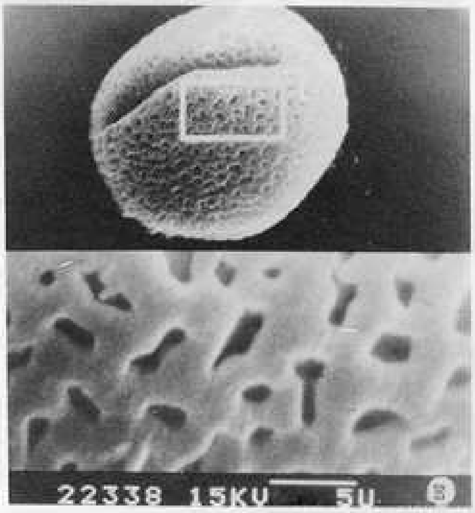

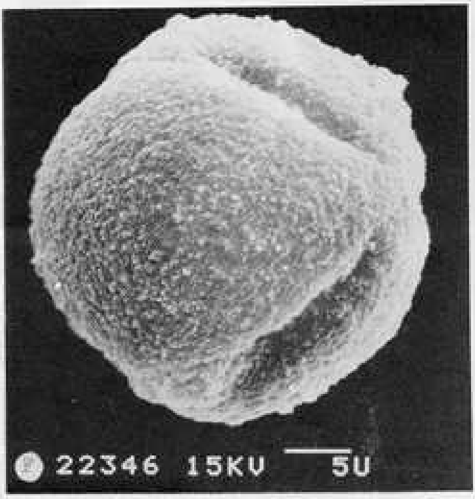

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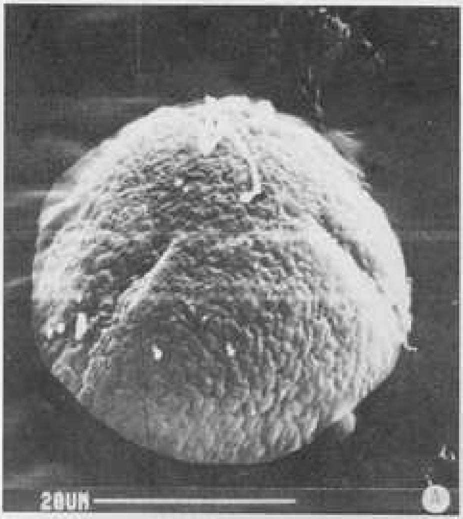

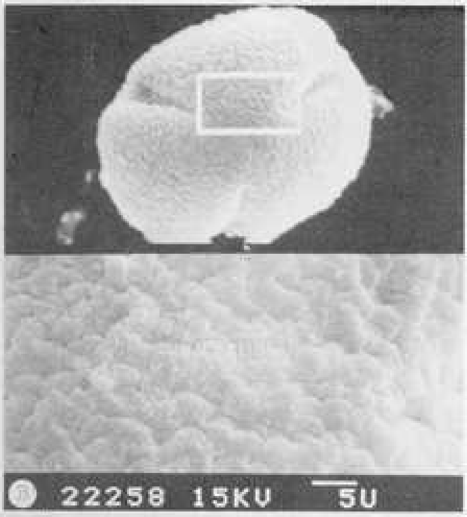

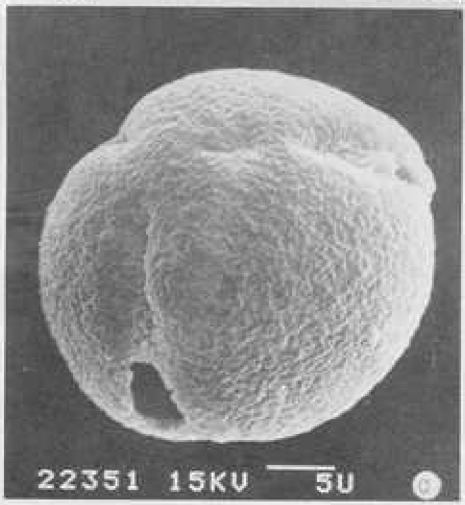

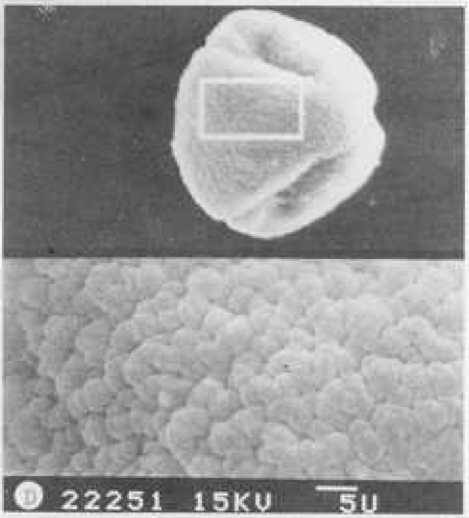

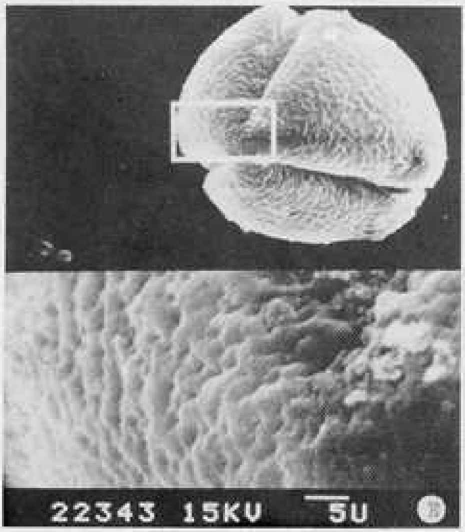

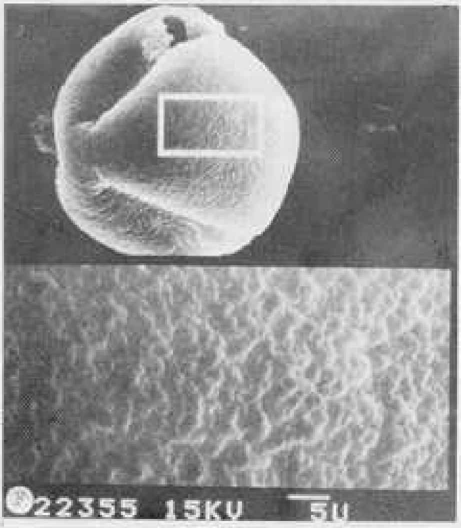

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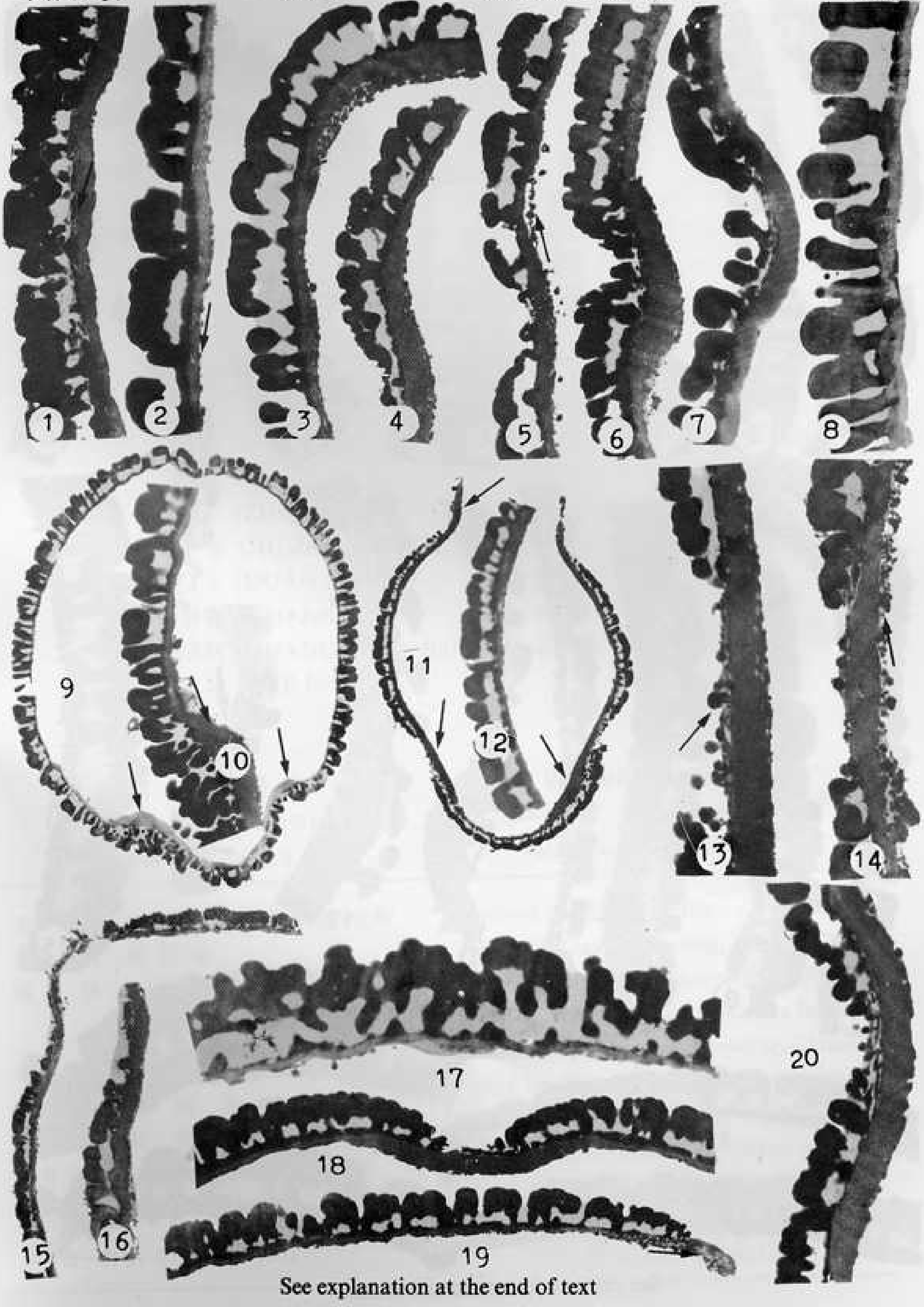

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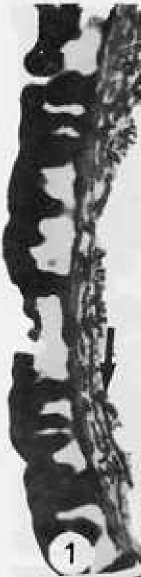
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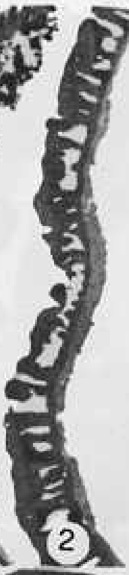
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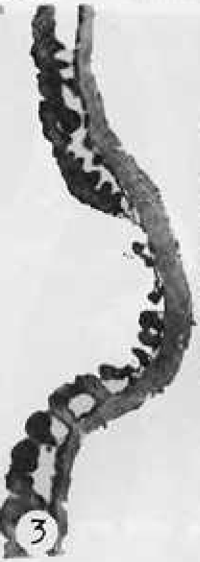
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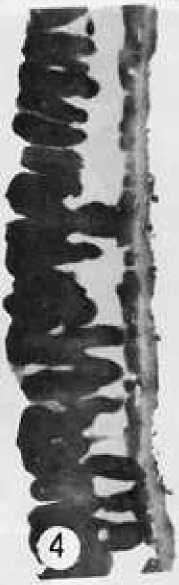
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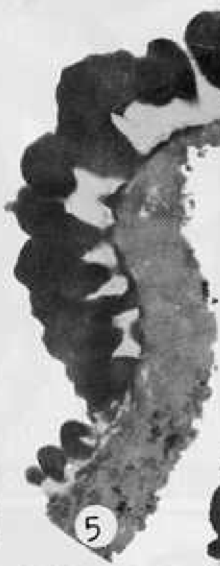
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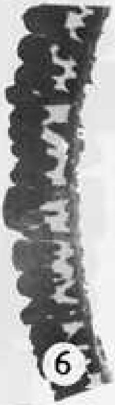
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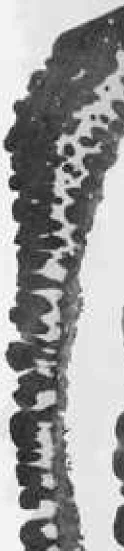
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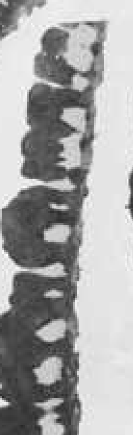
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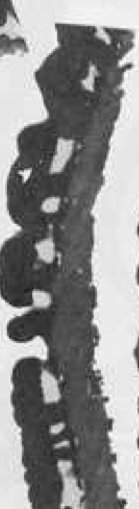
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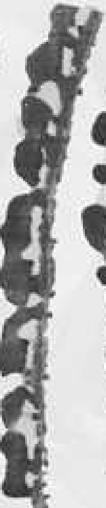
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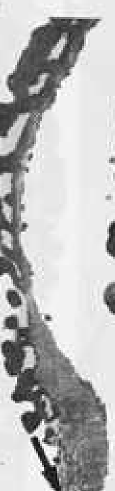
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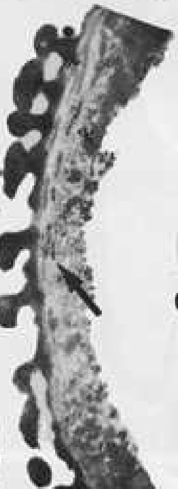
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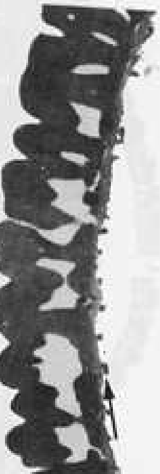
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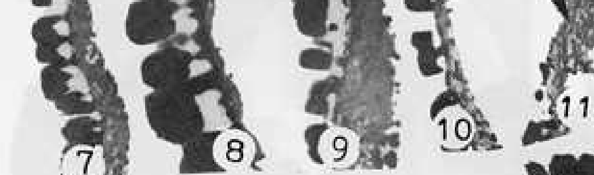
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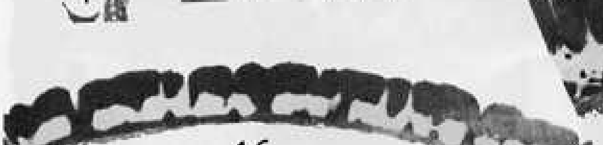
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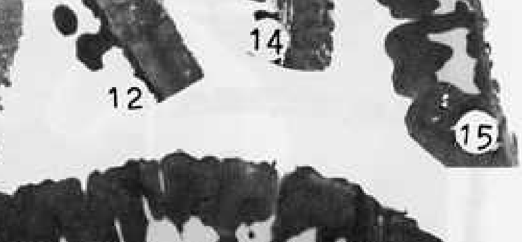
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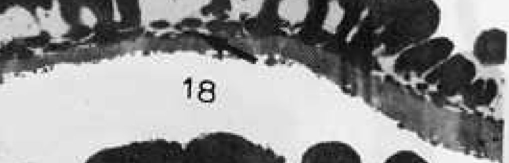
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